

## SOME NEGLECTED POINTS IN THE PHYSIOLOGY OF VISION.

BY

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With all the last-century study of the laws of optics and of the organ of vision, it is strange that the significance of so many ocular structures and functions has been misconceived or neglected. Most extensive investigations with the keenest ingenuity have been made upon the photochemistry of the dead retina,<sup>1</sup> and yet the important organs and essential functions concerned, in the living eye, in the avoidance of retinal exhaustion, and the reinstitution of retinal sensibility, have been left almost unnoticed. Theories of vision have been elaborated with tireless ingenuity, and yet the fundamental conditions of actual vision have not been recognized. All the theories may be left out of the attention if we wish to fix upon the fundamental fact and causes of retinal fatigue, and the methods and devices for reestablishing retinal sensibility. In truth the observation underlying all theories is that the persistent action of the light-stimulus or image upon one part of the retina speedily lessens and extinguishes the sensation-response. The more intense the light the greater the injury, and the quicker it is produced. The reinstatement of sensitiveness is by means of shadings, darkness, and variations of the stimulus. I have seen no systematic and thoroughgoing statement of the devices and the methods whereby this deterioration of function is prevented, and the resensitizing process is brought about. The matter is of so much practical significance that they deserve enumeration:

1. The shadows cast by the retinal arteries, veins, and capillaries, according to the direction and intensity of the entering light, are constantly shifted and modified, so that the retina behind them and in their immediate neighborhood is allowed variations of fatigue and recuperation. The most shaded portions serve perhaps as

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<sup>1</sup> Epitomized in the "System" of Norris and Oliver, Vol. I.

centers whence extends the mysterious resensitizing process.

2. Certain sensitive and trained eyes, when looking toward the sky or a bank of cloud, can see a multitude of little lights like pin-points flashing in and out of view all over the field of vision. These may be resolved into illuminated paths or lines of light, zigzagging everywhere and appearing and disappearing seemingly without law or order. These have been called phosphenes, corpuscular reflections, phoses, and aphoses.<sup>1</sup> They are the reflections from the blood-corpuscles of the capillaries of the retina, which, as they turn and twist along their routes, act as tiny mirrors to throw darting points or traveling lines of light upon all parts of the retina. These multitudes of corpuscles also, of course, cast unobserved shadows of themselves upon the retina. The reflections may also have a function in producing needed physiologic irritation in parts of the retina not habitually stimulated by the incoming light, and in this way keeping it in a state of preparedness or responsiveness.

3. The shadows of *muscæ volitantes* are probably of greater service. *Muscæ* should be recognized as of physiologic, not pathologic, significance. They exist in all eyes, although not usually recognized. Every part of the fundus of all eyes during the waking life is protected by these floating and waving *muscæ* shadows.

4. The retinal pigment extends so far toward the periphery of the retina that functionally it joins that of the iris in preventing all light, except that slight amount possibly transmitted through it, from entering the interior of the eye except through the pupil.<sup>2</sup>

5. The iris-pigmentation is essential for retinal shading. The tragedy of albinotic eyes is largely due to iris-translucency.

6. The alternation of contraction and dilation of the pupil under ever varying light-changes and intensities varies the size of the retinal image, and in this way adds another to the agencies inducing changes of stimuli and rest.

7. The natural pigmentation of the skin in the non-albinotic gives added exclusion of useless and harmful

<sup>1</sup> See an article upon the subject in the Philadelphia Medical Journal, July 22, 1899.

<sup>2</sup> The strange tendency of xanthelasma and other pigment spots to appear upon the lids and about the eyes, bears witness to the difficulty of attainment of normal ocular pigmentation. This is still more striking in the pathologic dark rings or half-ellipses that appear about the eyes of girls and women suffering from anemia, chlorosis, and other forms of denutrition.

light which passes more freely through the eyelid of the albino.

8. The function of the eyelashes has been supposed to be the protection of the eyeball from a striking body, which, first touching the lashes, is followed by reflex closure of the lids. I am convinced that the lashes are of little or no service of this kind, and that their predominant use is to screen the light and shade the pupil, while at the same time allowing the passage of sufficient light to give a useful image of an object above or below the eye. The existence of this function can be observed in others who are standing in sunlight, or in the photographs of sitters in open daylight, etc.

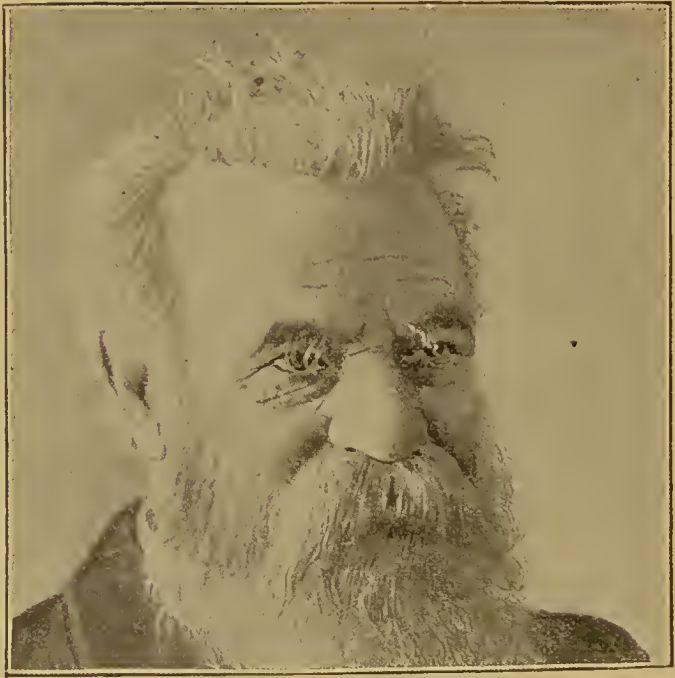
9. Winking has been explained as necessary for moistening and cleaning the cornea and spreading the tears uniformly over the exposed surface of the eye. It has this function, of course, but another, fully as important if not more so, is that of completely shutting out the entire retinal stimulus for an instant thousands of times a day. That winking is not necessary for spreading the tears, cleansing the cornea, etc., is shown by the absence of winking in so many animals.

10. Binocular vision also serves more than would the cyclopean eye in breaking up the continuance of the stimulus of the retina upon any one spot.

11. Of greater importance than any single one of the preceding devices is that of the incessant movements of the eyes, those of the body and head aiding. In a child it is almost impossible to secure any steady fixation of the axis of vision, even for a few seconds, and the eyes of adults, when healthy, are thus held with difficulty for only 10 or 15 seconds at most. But the motionless stare of the blind or highly amblyopic eye is noticed even by the layman. This ceaseless motion of normal eyes produces a similar rapid variation of images, shadings, and rests of all parts of the retina in the region of the macula. The nystagmus of albinotic eyes may be defined as the ceaseless chase after a portion of the retina which may have been a little less exhausted than others by the terrible flooding of the entire retina with light.

12. The eyebrow does, indeed, have the subordinate function of leading water and the sweat away from the palpebral opening, but a more important use of it is to shade the eye. A noteworthy confirmation of this is the otherwise inexplicable growth of the eyebrow hairs in old men. A striking example is shown in the photo-

graph of the lately-deceased scientist, Powell, shown herewith, and reproduced from *Science*, October 10, 1902. I have sometimes had to cut off these long hairs in the aged in order to keep them from injuring the eye by incurvation against the eyeball. In old age the resensitizing process of the retina is more difficult owing to failing nutrition, etc., and there is a need for a still greater protection of the pupil from the incident light of the sun and sky. This is effected by the visor of the eyebrow, which at this time of life frequently takes on a



Photograph illustrating the excessive growth of the eyebrow in old men.

startlingly luxuriant growth. This naturally occurs in men and not in women.

Some of these minor devices doubtless serve the purpose suggested only incidentally, or accidentally, but nevertheless actually, and one must be struck by the fact that so many different methods combine and cooperate toward a common end. One will scarcely find in the entire organism such a startling number of diverse mechanisms focussing to one final aim and result. If the



end were not of the supremest importance this would hardly be permitted. If interruption of the stimulus were undesirable, the ingenuity of nature would have found a dozen ways to prevent it instead of as many to encourage it.

These numerous devices are, in fact, but a very few of the many proofs of the enormous difficulties met and conquered by nature in the evolution of the eye. These difficulties are, apparently, a hundred times as numerous and as complicated as those of any other organ of the body. Hence the fineness of the adjustment, the ease with which disease takes the place of health, the limits of normality being almost infinitely delicate and narrow. A glimpse into this amazing mystery is caught by the observation that all this diverse mechanism from cornea to macula must be highly transparent, and yet the greater portion is not controlled by nerve-agencies, and all is nourished by blood which is scarlet! And millions of transparent optic nerve fibers divested of their insulating covering must perform independent and accurate functions!

The most fundamental of the difficulties of the ocular mechanic has undoubtedly been to create a mechanism that shall respond to a stimulus lasting but 0.00144 of a second, and that is hundreds of millions of millions of times more slight than that of sound. This explains why the receiving mechanism or photographic plate of the retina can be kept sensitive for only a few seconds. In order to resensitize it a change or cessation of the stimulus must be ensured at least every few seconds. Hence the elaboration of at least twelve methods of ensuring the result.

There are many practical lessons to be derived from the physiologic mechanisms mentioned. The almost universal custom of wearing hats, bonnets, caps, etc., finds its *raison d'être* in the need of shading and protecting—not the head so much as the eyes. The chief suggestion that arises is of course the avoidance of subjecting the eye to a constant stimulus or to a harsh or intense light. It is amazing what the eye will endure when its ametropia is perfectly corrected. It is equally astonishing how easily a little ametropia morbidizes the whole bodily and nervous organism. But it must be noted that not even reading demands absolute uniformity and continuance of the image. There is always a gliding and changing of the shape and size of the image by fluctuations, interruptions, shadings, variations, etc.

If our reading was always by means of a consecutive series of letters each appearing for a fraction of a second at one and the same point, there would be very little reading possible. But even with large print, and good paper and ink, one should not demand fixation of the eyes too long at a time. There should be little rests by closing the eyes, looking away, etc., at least every few minutes. In all continuous eye-work of any kind there should be such interruptions. The light should also not be in front, but should illuminate the book, paper, sewing, etc., from behind or above. The book should be held as nearly on the level of the eyes as possible. It is a pity that printing with white ink on a dead black surface is at present an impossibility.

When this important law of retinal fatigue and recuperation is recognized, there will take place a speedy revolution in almost all our practical and esthetic arts. The furniture, wall-papers, carpets, curtains, and windows of our houses will then be very different from what they now are,—and more beautiful also! Let us more closely consider one or two of the many illustrations.

It should dictate the fundamental tones, colors, shape, and extent of our picture-frames. By the old-fashioned gilt barbarisms the artist allowed the framer and gilder almost to monopolize the mental, emotional, and physiologic attention of the spectator and to detract as much as possible from interest in the picture itself. It is only for a few seconds that any human eye can look at a picture when the greater portion of the retina is outraged and exhausted by the adjacent images of the atrocious frame. In the ordinary gallery of pictures these ludicrous and retina-paralyzing frames, close beside each other, become positively torturing. It all seems designed to exhibit, not art, not nature, not esthetic charm, and emotional peace, but only the abject hideousness of the plebeian framegilder's unart. Almost every traveler has noticed the utter exhaustion and headache that is produced by a short visit to a large picture-gallery. The crude harsh gilt is the most wearying of all colors. Recently there has arisen a reaction of which probably no one understands the reason, consisting in the making of frames with solemn and monotonous black. This extreme is infinitely preferable to the other, but it is also mechanical and stupid. Each picture should be framed by the painter, or at least, and because he has shown himself so blunderful about it, by another artist with this single

task in view. Each picture presents a special problem to the artistic framer. It should be done so as to produce a peculiar, logical, and physiologic color-effect, as little wearying to the eye as possible, while dictated primarily by the character, the colors used, the esthetic aims, etc., of the painter. It should by all means be hung sufficiently apart from all other pictures to allow it the proper necessities of its own individuality and not to destroy that of others hung in the neighborhood. Pictures crowded together give evidence of esthetic sin quite as decidedly as the physical crowding of human beings demonstrates other sorts of immorality. In a word, the present fashion of framing and hanging pictures could not be more unesthetic and anesthetic, more unphysiologic and pathologic, than it is.

Another corollary of the law of ocular tire and re-sensitization may be noticed in passing—a law that is outraged by the lighting of most of our churches, and of all of our private houses, theaters, public halls, etc. The millions of dollars spent each year in illumination are in great part wasted and misspent, and by the methods used all the harm is done to the eye that is possible. No room should be lit in such a manner that the individual lights are visible.<sup>1</sup> Illumination should be transmitted, dissipated, and reflected light. There is nothing more tiring to the eye than numerous separate lights whose images upon various parts of the retina create there a large number of useless and exhausting stimuli and from which there is no escape by any device or turning. American oculists have so many patients who, even with the best spectacles, cannot escape suffering whenever they go to the theater, opera, etc., that the term “theater-headache,” or “panorama headache,” has come into general use. As much as to the character of the sermon or of the worshiper, the famous sleepiness of the church-goer was due to the somnolence caused by ocular fatigue from harsh lights in front. One of the most common symptoms of eye-strain, known of all oculists, is sleepiness when reading by artificial light. Part of this is certainly due to unphysiologic systems and qualities of the light used.

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<sup>1</sup>See an article entitled “Artificial Illumination,” by Dr. L. A. W. Alleman, in the Brooklyn Medical Journal, December, 1900.

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